



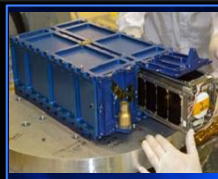
Secondary Payload Deployment System

Topic: Cube Quest GT1 Documentation Preparation

Date: 06/11/2015

Org: George Norris/FP30

Space Launch System





Agenda

- Introduction
- IDRD Description
- SPUG Questionnaire
- Payload Overview
- Operations Overview
- Hardware Design
- Analysis
- Test/Demonstration
- Safety Data Package (SDP)
- Project Schedule
- Questions



Introduction

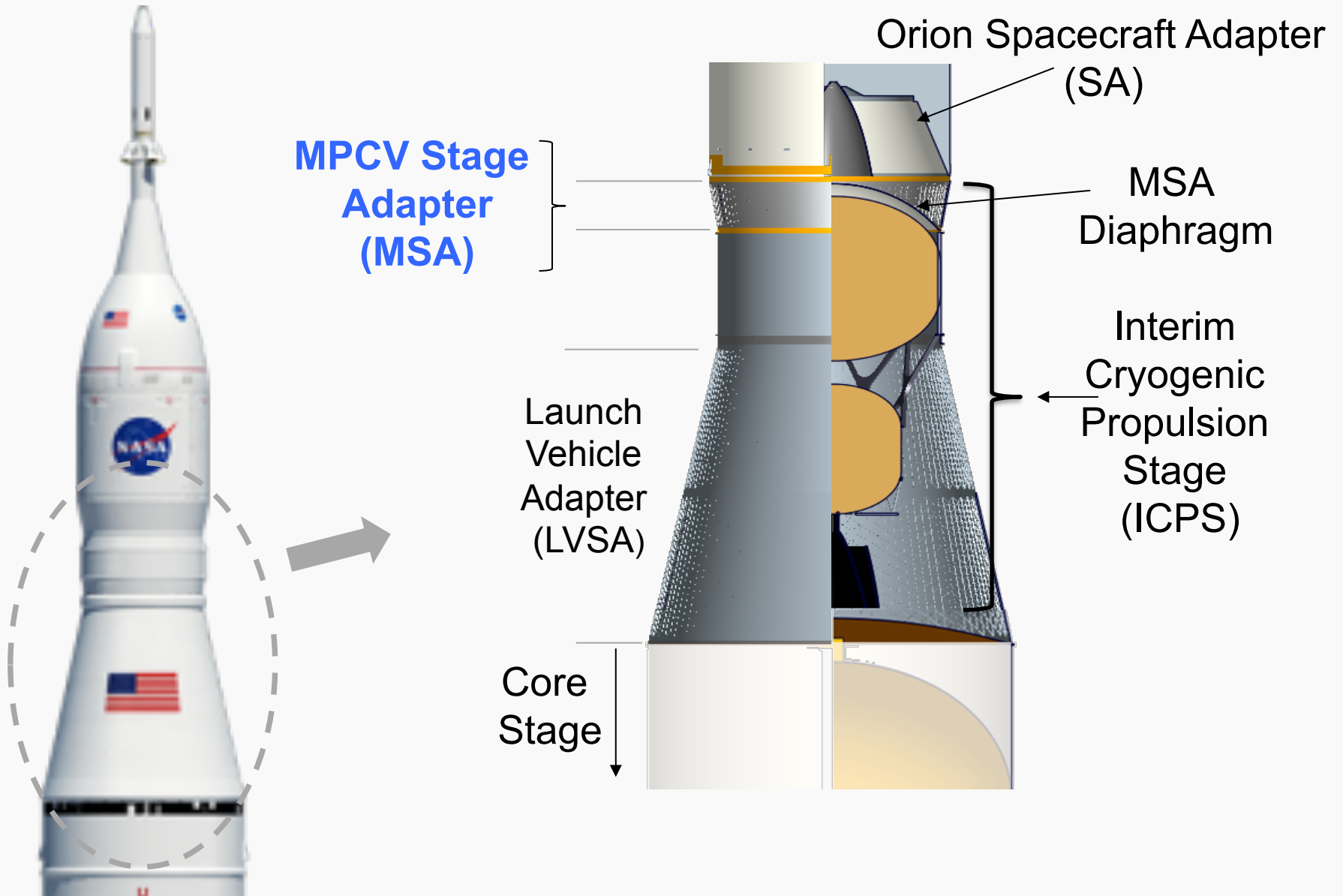
The following is to provide clarity/understanding as to what is required for Ground Tournament #1 documentation submittal, concerning SLS interfaces & safety information.

- GT#1 data packages are due no later than July 3, 2015
- Submitted data will be reviewed for completeness & clarity
- Judges scoring will be weighted on a 1 to 5 scale w/ 5 being the strongest
- Information for this section will cover the SLS interfaces & safety and along with the GT compliance rules, will comprise 60% of the GT#1 score
- Questions can be asked at the end of the presentation & up until data package delivery

Supporting Data:

- Secondary Payload User's Guide (SPUG)
- Interface Definition and Requirements Document (IDRD)
- Safety Presentation Template

SLS Configuration

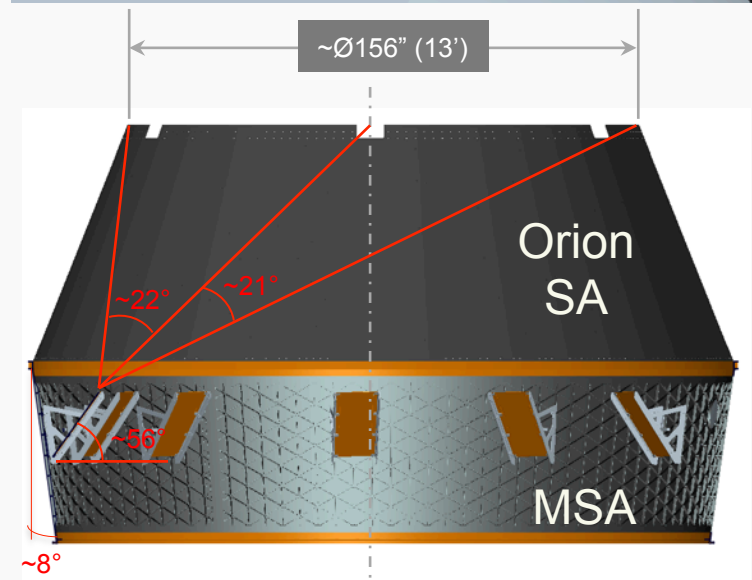
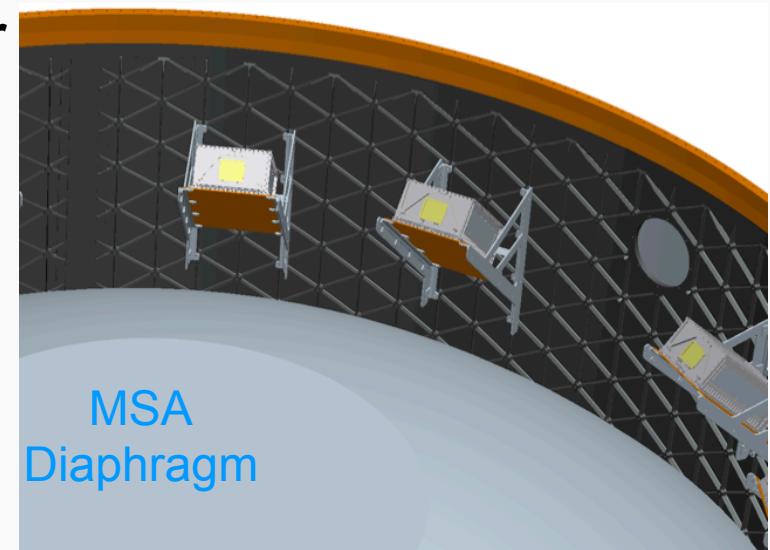


Systems Description & Purpose



Expand and fully utilize the SLS capabilities for exploration purposes without causing harm or inconvenience to SLS or its primary payload.

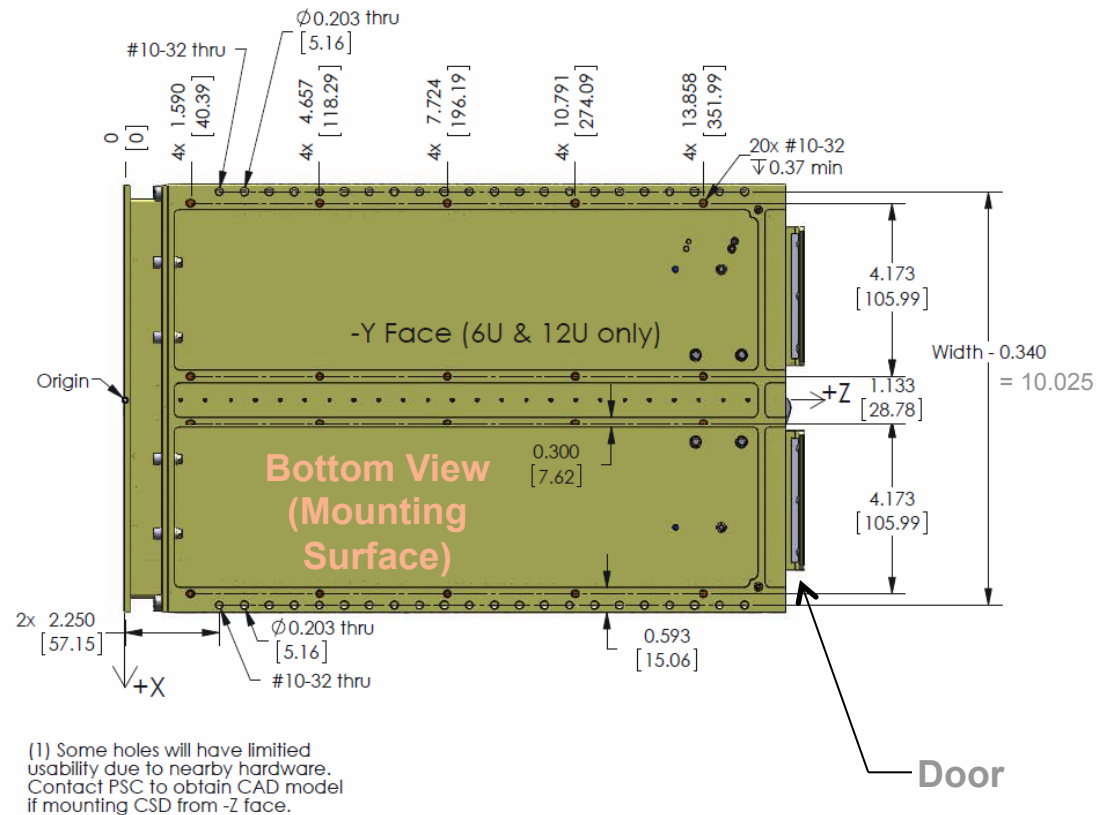
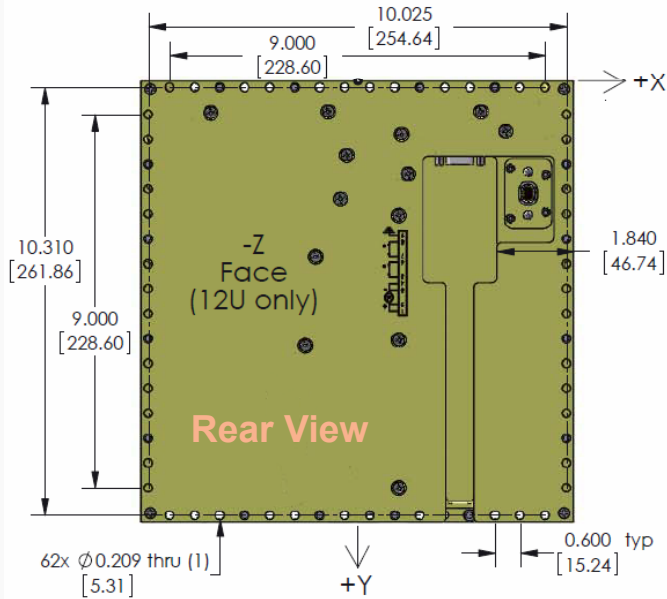
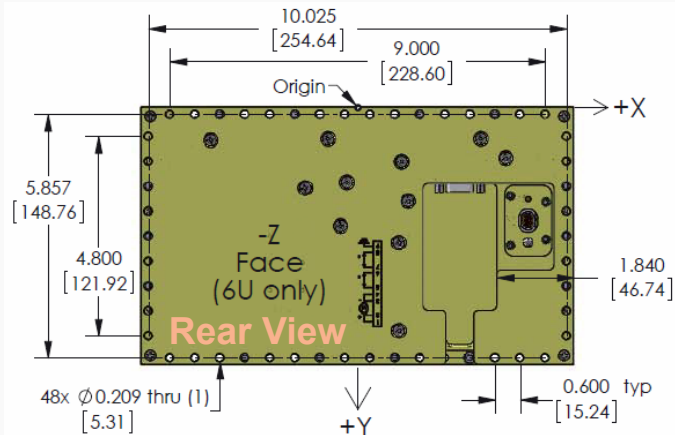
- **Eleven** 6U payload locations
- 6U volume/mass is the current standard (14 kg payload mass)
- Payloads will be “**powered off**” from turnover through Orion separation and payload deployment
- Payload Deployment System Sequencer; payload deployment will begin with pre-loaded sequence following MPCV separation and **ICPS disposal** burn
- Payload requirements captured in Interface Definition and Requirements Document (**IDRD**)



Dispenser Status



Planetary Systems Corporation - Dispenser



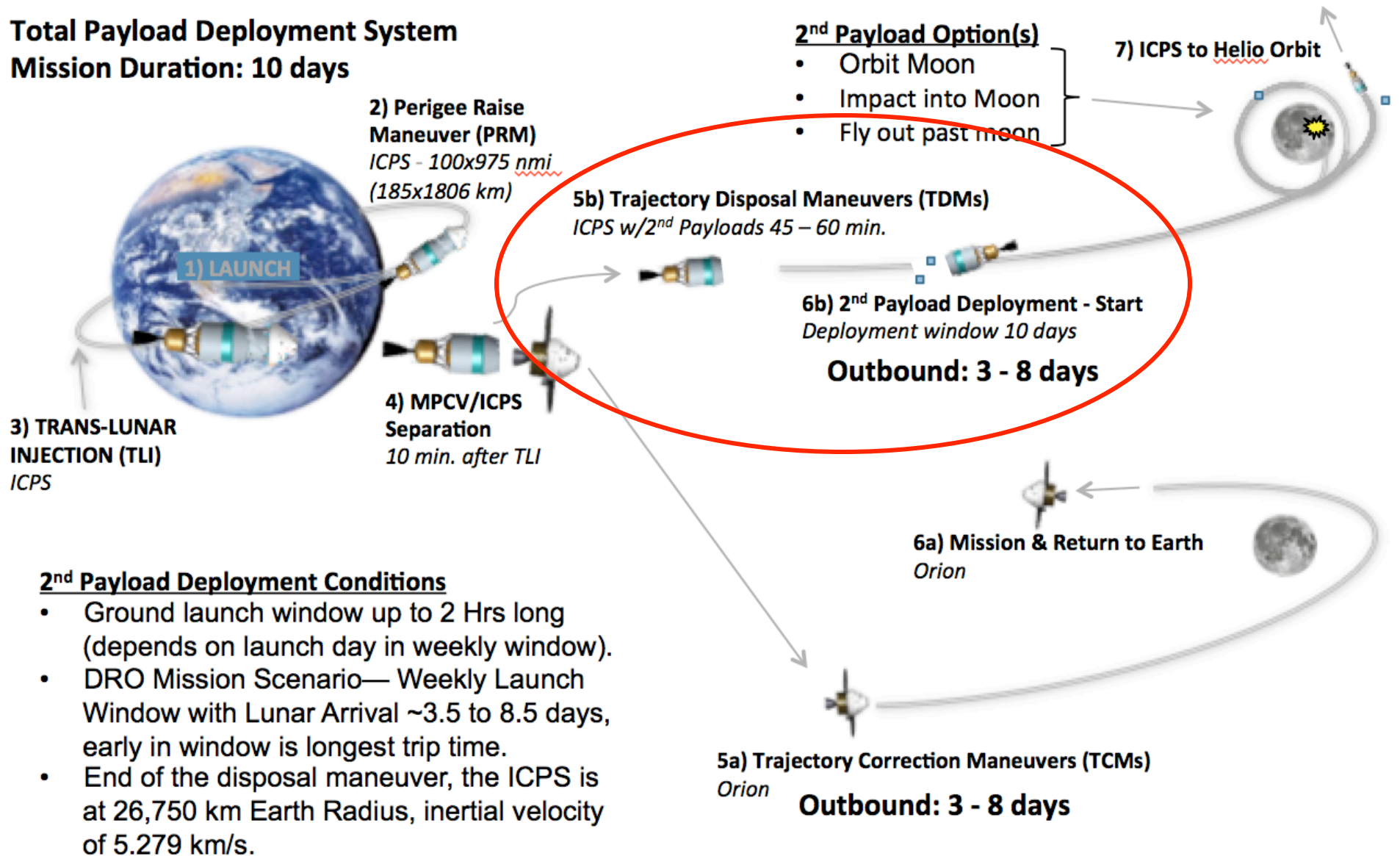
**Mounting Patterns Unique to 6U and 12U
(6U & 12U use same pattern)**

Operations Plan



Total Payload Deployment System

Mission Duration: 10 days





IDRD Description

The Interface Description Requirements Document (IDRD) provides the SLS interface, service conditions, and safety requirements which payloads (cubesats) must meet to fly on SLS EM-1 launch.

- Mechanical interfaces includes: mass & C.G., attachment pattern, & volume restriction
- Electrical interfaces include: battery charging, grounding/bonding, dispenser activation
- Environmental interfaces: natural environments (Earth & space conditions) & induced environments (vehicle caused conditions)
- Safety requirements (many of the requirements will be dependent upon payload design solutions)
- Verification methods will be defined for each requirement as an appendix

SPUG Questionnaire



Required Deliverable:

- Complete & submit the questionnaire (questionnaire is located in the back of the Secondary Payload User's Guide (SPUG) SLS-SPIE-HDBK-005, appendix C, page 54)
- Questionnaire can be completed in Word or Excel

Questionnaire Description:

A set of questions to be answered by a payload. The questionnaire serves several purposes;

- Describe payload objectives & plans
- To gauge payload to vehicle compatibility
- Help assess future payload needs

Scoring Criteria:

- 1 - <3/4 of form completed
- 3 - form completed but vague answers
- 5 - form completed w/solid information

CubeSat Overview



Required Deliverable:

- Provide description of payload
- Describe Technology Readiness Level (TRL) of system(s) & ability to mature to TRL6 by GT#4 – As it relates to basic functions (i.e. propulsion system, power system, etc.)
- Define payload unique requirements / goals

Payload description & TRL discussion needs to be in paragraph form in Word

Requirements/goals can be in paragraph form in Word, bulletized form in PowerPoint, or in Excel spreadsheet

Scoring Criteria:

- 1 – major gaps in description, TRL not clearly defined, no unique systems defined
- 3 – basic description provided, TRLs determined & plan mentioned to mature, limited requirements/goals listed
- 5 – thorough description, clear TRLs w/ plans to mature, solid requirements / goals defined

TRL – NASA technology maturity scale

Levels

- 9 – Flight proven system
- 8 – Flight qualified system (ground or flight)
- 7 – Demonstrated prototype system
- 6 – Demonstration of a system model (ground or space)
- 5 – Component/breadboard validated in environment
- 4 – Component/breadboard validated in lab
- 3 – Analytical/experiment proof-of-concept
- 2 – Formulated a concept
- 1 – Have a basic principle/idea

Concept of Operations



Required Deliverable:

- Provide description of mission operations & goals
- Reference mission concept registration data package

Mission operations discussion needs to be in paragraph form in Word, may include diagrams or timelines to aid in describing operations

Types of things to include are:

- Goals planned to achieve in flight
- Processes/steps which will be performed in flight
- Communication plans (i.e. one-way, two-way, none, etc.)
- *Mission State Modes – a forerunner to software development

Scoring Criteria:

- 1 – provide basic mission goals & description
- 3 – provide detailed mission steps w/ goals at each step
- 5 – provide detailed mission steps w/ goals & *mission state modes

*Mission State Modes – A block diagram indicating software operations (i.e. start-up, position/alignment, battery status, thermal check, etc.) and their relationship to one another

Some functions will be performed once while others will be constantly repeated

S/W algorithms will be developed for each block, in the future

Hardware Design



Required Deliverable:

- Provide system schematic(s) (system/subsystem block diagrams w/high level of interfaces identified)
- Provide general hardware descriptions
- Initial mass properties
- Some detail on system/subsystem w/ potential safety issues (i.e. propulsion, power, transmission levels, etc.)
- Reference mission concept registration data package

Hardware design discussion needs to be in paragraph form in Word, include diagrams & lists to aid in describing design

Scoring Criteria:

- 1 – rough block diagram, little hardware description, no mass breakdown, no system details
- 3 – top level system diagram w/details, mass properties at a system level, some systems w/safety issues identified
- 5 – top level system diagram, & mass properties at the component level, all subsystems safety issues discussed

Verification - Analysis



Required Deliverable:

- Identify planned analysis (reference IDRD for each verification category)

Analysis discussion needs to be in paragraph form in Word, include lists, type of analysis, method of analysis tool(s), & schedules to aid in describing analysis

Scoring Criteria:

- 1 – only mentions analysis
- 3 – identifies/lists analysis w/plans of when to be performed
- 5 – all above & provides some initial analysis (back of the envelope analysis)

Verification Methods:

Analysis – techniques may include systems engineering analysis, statistics and qualitative analysis, computer and hardware simulations, or analog modeling.

Test – operation of equipment where measurements are collected and fall into one of two categories; functional or environmental.

Demonstration – operation of equipment w/no measurements collected.

Inspection – physical evaluation of hardware and/or documentation/drawings.

Similarity – assessment is similar or identical to another item that has previously been verified.

Validation of Records – use of vendor or interfacing project supplied verification metadata or furnished/supplied manufacturing or processing records.

Verification – Test/Demonstration



Required Deliverable:

- Identify planned testing & demos (development & verification) (reference IDRD for each verification category)

Test/demo discussion needs to be in paragraph form in Word, include lists, type of tests, & schedules to aid in describing tests

Scoring Criteria:

- 1 – only mentions testing
- 3 – identifies/lists analysis w/plans of when to be performed
- 5 – all above & provides some initial analysis (back of the envelope analysis)

Safety Data Package (SDP)



Required Deliverable:

- Presentation (summarized version of Hardware Design deliverables w/ emphasis on possible hazards)

Safety package discussion needs to be in PowerPoint presentation format

(Presentation to include payload/cubesat design goals/intent, descriptive block diagrams of system(s), planned operations, description of possible hazards, etc.)

Scoring Criteria:

- 1 – provides a presentation but greatly lacking info/needs to be redone
- 3 – provides a presentation w/minor changes required
- 5 – presentation meets requirements & needs no changes



Phased Safety Reviews

Phase 0 Review – Presentation only – shows general payload concept and operation while suggesting areas of concerns for potential hazards. Opportunity for the Payload Safety Review Panel (PSRP) to understand the payload, make suggestions, & payload developers to ask questions.

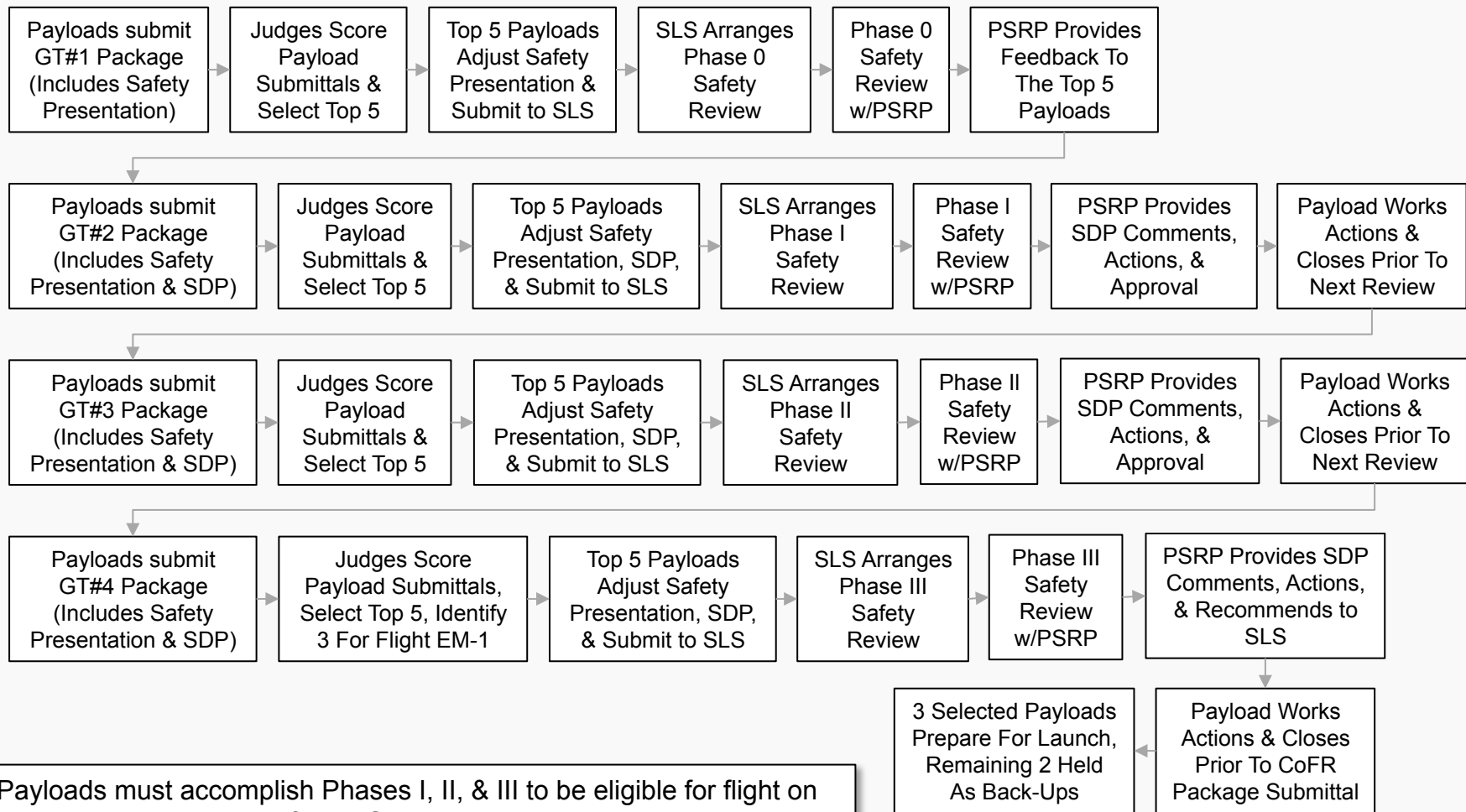
Phase I Review – Presentation & Safety Data Package (SDP) w/Hazard Report – show a detailed design and discuss operations in a time sequence. SDP w/HR identifies all payload hazards per the describe categories. PSRP determines acceptance of SDP w/HR.

Phase II Review – Updated presentation & Safety Data Package (SDP) w/Hazard Report – show updates & changes to design and operating plans. SDP w/HR identifies method of verification to all agreed upon hazards from Phase I review. PSRP determines acceptance of SDP w/HR.

Phase III Review – Updated presentation & Safety Data Package (SDP) w/Hazard Report completed – shows methods & results for verification closure of all hazards from Phase II review. PSRP recommends acceptance of SDP w/HR to SLS & KSC safety.

SLS Secondary Payload Safety Process

(Cube Quest Challenge Payloads)



Project Schedule



Required Deliverable:

- Detailed plan to GT#2
- Milestone events to other GTs

Schedule discussion needs to be in PowerPoint, Word, Excel, or a PDF format

Overall project schedule to show plan to get to certification & hardware delivery for integration into vehicle.

Scoring Criteria:

- 1 – provides only a top level schedule
- 3 – provides detailed plan to GT#2 & milestones to other GTs
- 5 – provides detailed plan to GT#2 & GT#3 w/milestones to GT#4

Key Milestones:

GT#1 – August 2015
GT#2 – February 2016
GT#3 – August 2016
GT#4 – February 2017
Phase 0 Safety Review (top 5) – Sept. – Oct. 2015
Phase I Safety Review (top 5) – Jan. – Apr. 2016
Phase II Safety Review (top 5) – Oct. – Dec. 2016
Phase III Safety Review (top 5) – Apr. – Jun. 2017
KSC Safety Review (ground) – Aug. 2017
Integrated Payload Data for COFR – Nov. 2017
Integrated payload delivery to KSC – Feb. 2018
Integrated payloads mounted in MSA – Feb. 2018
Vehicle 1st roll-out – May 2018
Vehicle final roll-out – June 2018
EM-1 Launch July 2018

Conclusion



SLS interfaces & safety portion of the Ground Tournament packages:

- Makes up ~60% & will be judged accordingly
- SLS main concern is payload design maturity & vehicle protection (safety)
- IDRD is now available for public access, updates will come first of next year
- SPUG Questionnaire is needed by SLS to better serve payloads
- A Secondary Payload Integration Manager (SPIM) will be assigned in July/Aug. to work with top 5 selected payloads from GT#1
- Vehicle information will be updated to the Cube Quest community as it occurs
- The more information provided by the payload the better your chances of meeting SLS interface & safety needs
- We are happy to answer competitor's questions (whether 5 selected or not) through existing Cube Quest channels

Best of Luck at Ground Tournament #1

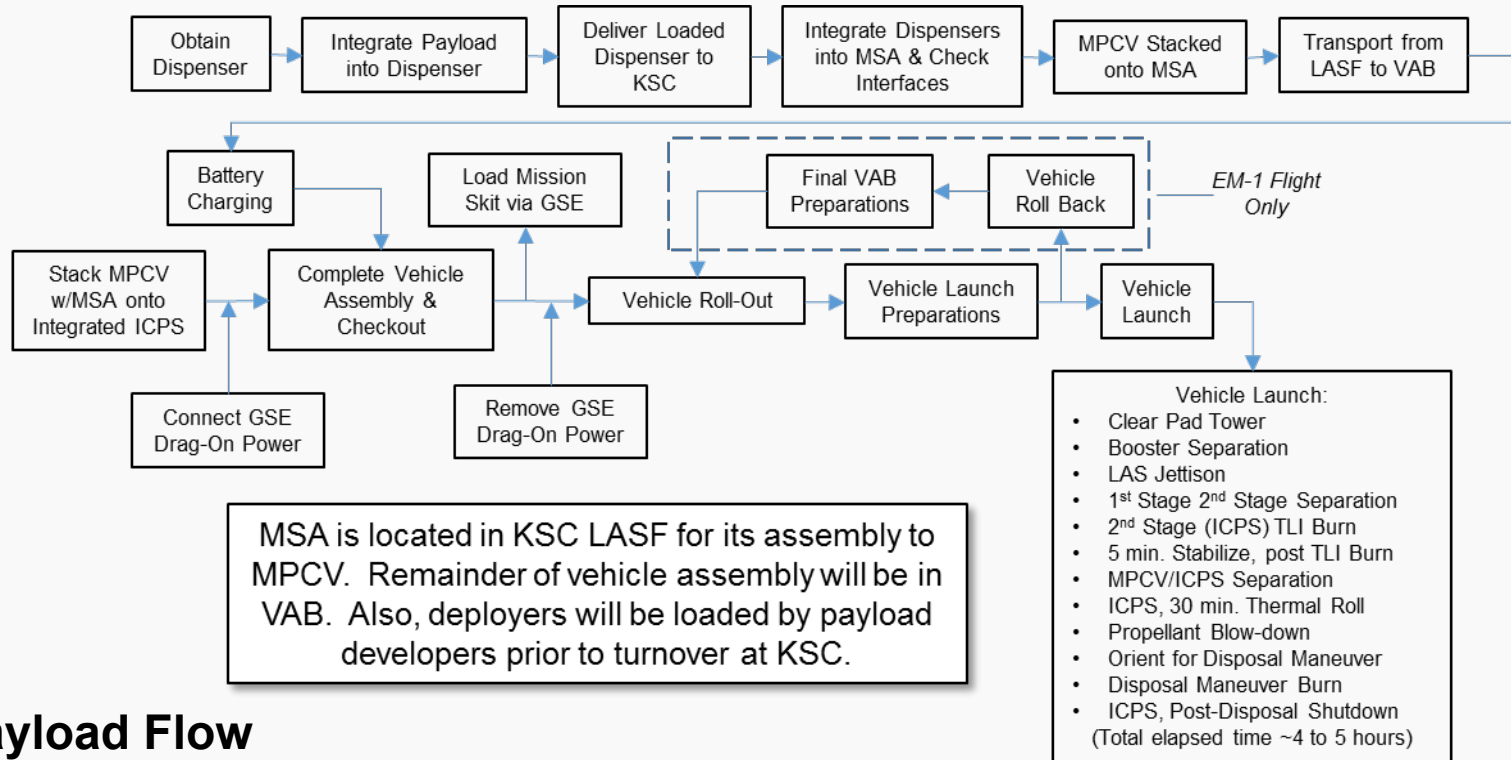


Questions?

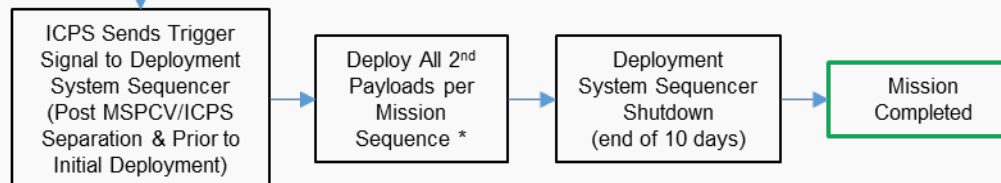


Back – Up Charts

Operations Plan



2nd Payload Flow (Operations Process)



* Deployment sequence needs a minimum of 5 sec. delay between individual deployments to guard against payload collisions w/each other.

Payload activation (envelope expansion & signal transmission) will be delayed a minimum of 15 sec. to assure clearing ICPS.

Operations Plan



Example Sequencer Mission Skit for EM-1

Sequencer Time Days/Hours/Min./Sec.	SPDS EVENT	Comments:	Mission Laps Time Days/Hours/Min./Sec.
00/00/00/00	ICPS Activate SPDS Sequencer	Sequencer activation after ICPS disposal complete	00/04/42/20
00/00/00/05	ICPS pulse Sequencer for Skit selection		00/04/42/25
00/00/00/07	PSDS Sequencer Completes Prep.		00/04/42/27
00/00/00/08	Payload #1 Discrete sent to dispenser	Earliest possible deployment point	00/04/42/28
00/00/00/13	Payload #2 Discrete sent to dispenser		00/04/42/33
00/00/00/18	Payload #3 Discrete sent to dispenser		00/04/42/38
00/00/00/23	Payload #4 Discrete sent to dispenser		00/04/42/43
00/03/30/00	Payload #5 Discrete sent to dispenser	Reduced Van Allen Belt radiation risk point	00/08/12/20
00/03/30/05	Payload #6 Discrete sent to dispenser		00/08/12/25
00/03/30/10	Payload #7 Discrete sent to dispenser		00/08/12/30
00/03/30/15	Payload #8 Discrete sent to dispenser		00/08/12/35
00/03/30/20	Payload #9 Discrete sent to dispenser		00/08/12/40
00/06/45/00	Payload #10 Discrete sent to dispenser	Cleared Van Allen Belt	00/11/27/20
00/06/45/05	Payload #11 Discrete sent to dispenser		00/11/27/25
00/06/45/10	Payload #12 Discrete sent to dispenser		00/11/27/30
00/06/45/15	Paylaod #13 Discrete sent to dispenser		00/11/27/35
00/06/45/20	Payload #14 Discrete sent to dispenser		00/11/27/40
09/23/56/40	Payload #15 Discrete sent to dispenser	Last Possible deployment, using ICPS lunar "g" assist	10/04/38/57
09/23/56/45	Payload #16 Discrete sent to dispenser		10/04/39/02
09/23/56/50	Payload #17 Discrete sent to dispenser		10/04/39/07
09/23/58/00	Sequencer check & shutdown	System off, mission complete	10/04/40/17

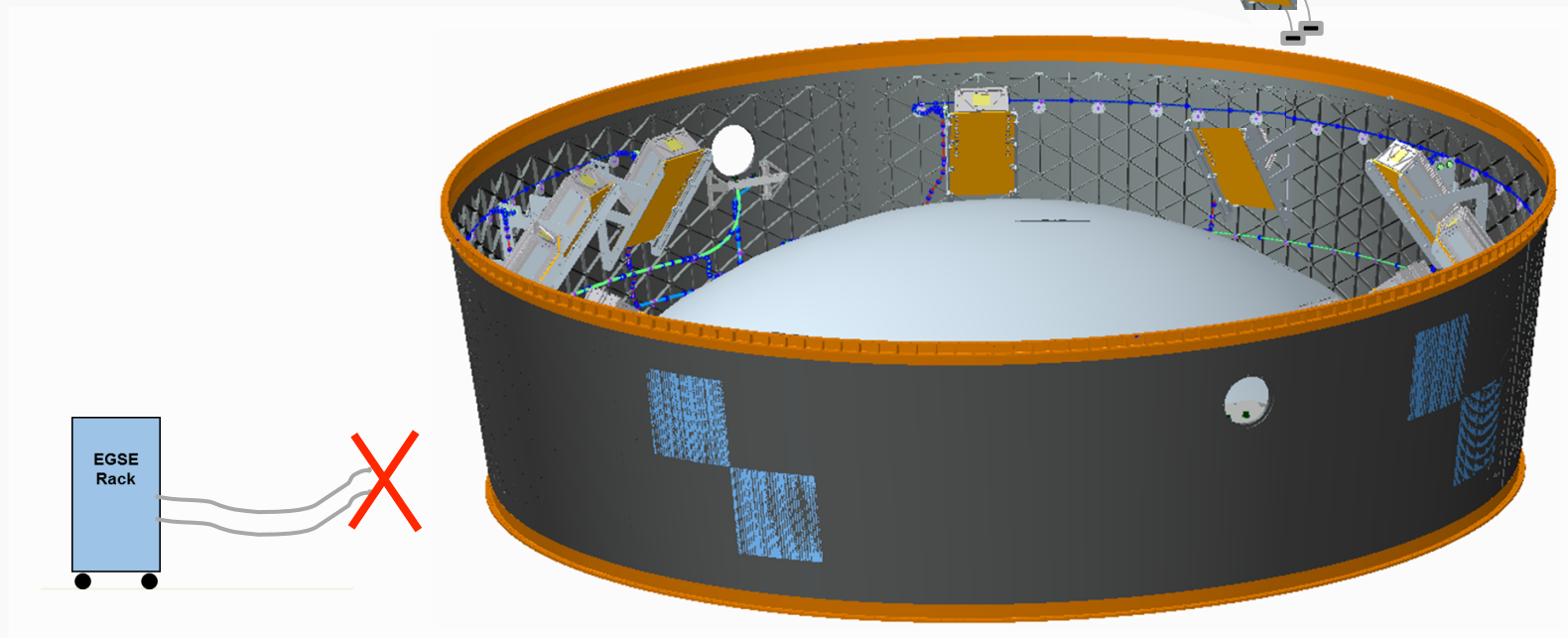
Disposal maneuver for ICPS is completed at launch + 4 hours 42 minutes and 17 seconds.

System Test Plan



Testing at KSC (Payload Integrated MSA) at Canister Rotation Facility (CRF) M7-777

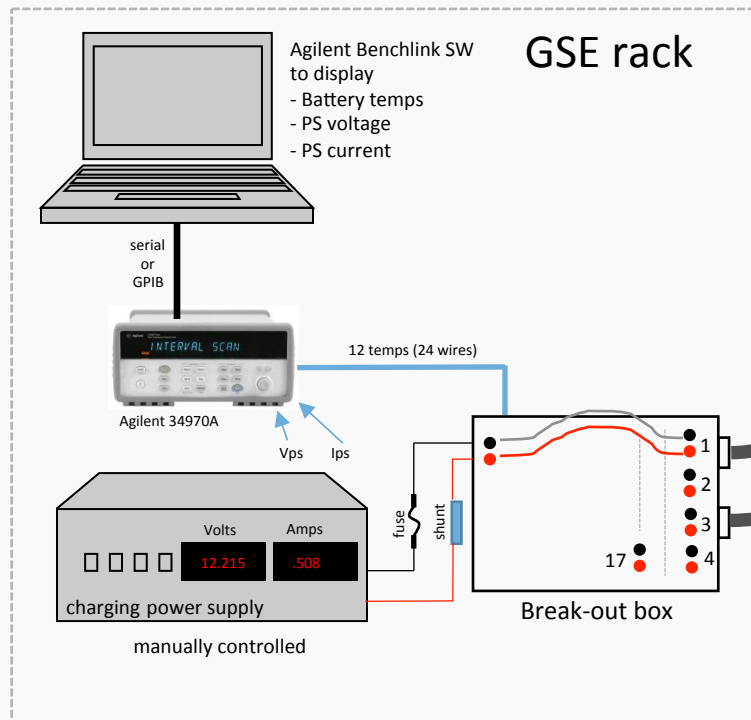
Bonding/Grounding test to show <1.0 Ohm resistance between dispenser and MSA bracket, once integrated dispenser has been integrated into MSA.



EGSE Description



Charging CubeSat/SPDS Batteries & Load Sequencer Skit



— Calibrated shunts to verify charge current of PS

SLS
MSA

Up to 12 batteries

